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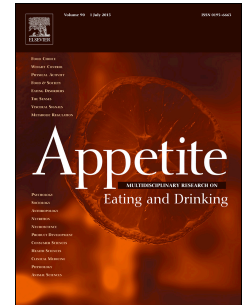
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Consumers' acceptance and preferences for nutrition-modified and functional dairy products: A systematic review

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Consumers' acceptance and preferences for nutrition-modified and functional dairy products: a systematic review.

Abstract

This systematic literature review collects and summarizes research on consumer acceptance and preferences for nutrition-modified and functional dairy products, to reconcile, and expand upon, the findings of previous studies. We find that female consumers show high acceptance for some functional dairy products, such as yogurt enriched with calcium, fiber and probiotics. Acceptance for functional dairy products increases among consumers with higher diet/health related knowledge, as well as with aging. General interest in health, food-neophobia and perceived self-efficacy seem also to contribute shaping the acceptance for functional dairy products. Furthermore, products with “natural” matches between carriers and ingredients have the highest level of acceptance among consumers. Last, we find that brand familiarity drives consumers with low interest in health to increase their acceptance and preference for health-enhanced dairy products, such as probiotic yogurts, or those with a general function claim.

Keywords: nutrition-modified and functional dairy products, systematic review, consumers' acceptance and preferences, attitudes, perceived healthiness.

1. Introduction

In the last decades consumer demand for health-enhancing food products, such as nutrition-modified (e.g. low-fat products or with fiber added) and functional foods, has grown rapidly. Consumer demand for health-enhancing foods has spurred in part because of socio-economic changes, such as the longer life expectancy, the rise of health care costs, the social costs of non-transmittable diseases, and the widespread desire for a better quality of life (Valls et al., 2013).

A recent report estimates that the global market for foods with health-enhancing features amounted to (approximately) \$168 billion in 2013, with an annual average

1 growth rate of 8.5%, and it is forecasted to exceed \$300 billion by 2020 (Research and
2 Markets, 2014). Food companies, attracted by such market growth and high margins,
3 have been investing in the development of new nutrition-modified and functional
4 products (Khan et al., 2014).

5 However, these market projections mask a high risk of product failure as 70 to 90
6 per cent of new health-enhancing products exit the market within the first two years
7 from their launch (Heasman & Mellentin, 2001; Stein & Rodríguez-Cerezo, 2008;
8 Hardy, 2010). One of the likely reasons for such high failure rates is that product
9 development is often driven by technical feasibility (Bleiel, 2010) disregarding
10 consumers' acceptance and preferences (Van Kleef et al., 2002; 2005a). This approach
11 may lead to a mismatch between consumers' needs and the features of new nutrition-
12 modified and functional food products introduced in the market (Van Kleef et al.,
13 2002). In spite of existing research having given great emphasis to consumers
14 acceptance and preferences towards nutrition-modified and functional foods (Van Kleef
15 et al., 2002; Verbeke, 2005; Ares & Gámbaro, 2007), existing knowledge is
16 fragmented, and the findings from studies conducted in different contexts appear
17 difficult to reconcile. One likely reason for this difficulty may be that so far scholars
18 have focused on only one or just a few aspects of consumer behavior, thus failing to
19 provide an integrated picture of the multiple elements affecting the acceptance and the
20 preferences for these products (Starling, 2014).

21 One approach used to gather relevant knowledge in fields where evidence is
22 fragmented is the systematic review, which selects studies through a multi-step
23 procedure (Cooper, 1998; Littell & College, 2006), also allowing for an assessment of
24 the studies' quality (Littell et al., 2008). To the best of our knowledge, only two
25 systematic reviews on functional foods exists (Ozen et al., 2012; Ozen et al., 2014).

1 Ozen et al. (2012) systematically reviewed twenty-three worldwide studies on
2 individual consumption of functional products belonging to different food categories.
3 These authors concluded that it was not possible to clearly identify how gender, age,
4 level of education and socio-economic characteristics influenced the consumption of
5 functional foods. Similarly, Ozen et al. (2014), by systematically reviewing studies on
6 European consumers, failed to identify gender differences in the individual
7 consumption of many categories of nutrition-modified and functional foods; however,
8 these authors pointed out a higher consumption of such products among North
9 European consumers.

10 The contradictory findings highlighted in these systematic reviews may be due to
11 the authors considered studies that focused on different products, for which consumers'
12 acceptance and preferences may be inherently different. Thus, the different attitudes
13 shown by consumers across product categories may have played the role of a
14 confounding factor, impairing the authors' possibility to isolate patterns characterizing
15 consumption. Such heterogeneity in results conflicts also with other literature reviews
16 (such as Sirò et al., 2008; Lähteenmäki, 2013) which have instead found specific
17 patterns in the role of consumer-related characteristics, such as gender, age, and some
18 psychological variables, as well as a clear role of product-related characteristics in
19 shaping consumers acceptance for nutrition-modified and functional products. The
20 primary goal of this paper is to investigate if, by focusing in one specific product category,
21 dairy products, it is possible to isolate common patterns in consumers' acceptance and
22 preferences for nutrition-modified and functional foods by means of a systematic review
23 process. Our secondary goal is also to provide an integrated picture of the multiple elements
24 affecting the acceptance and preferences for dairy products. We chose dairy products as the
25 category of interest for two reasons. First, dairy products are one of the biggest market segment
26 among nutrition-modified and functional products, accounting for nearly 43% of the total

worldwide sales (Ozer & Kirmaci, 2010). Second, dairy products are considered by consumers as one of the most credible product carriers to host functional ingredients, and consumers' acceptance and preferences towards nutrition-modified and functional dairy have been largely investigated in literature (*inter alia*, Van Kleff et al., 2005; Ares & Gambaro, 2007; Krutulyte et al., 2008; Siegrist et al., 2008; Sirò, 2008; Ares et al., 2010).

Gaining more insight on consumers' preferences for a wide range of health-enhancing dairy products may benefit both dairy manufacturers and consumers, as it will be illustrated throughout the manuscript. Furthermore, the results of this review, along with its limitations, will help identifying avenues for future research, as it will be illustrated in the final section of this article.

2. Methods

We used a systematic literature review methodology for the social sciences to select articles from online academic search engines. Compared to narrative reviews, the systematic literature review technique has the advantage of being based on an explicit and accurate study selection process which involves a multi-step procedure similar to that used in research surveys (Cooper, 1998; Littell & College, 2006). Additionally, the systematic review process required findings to be weighted according to the quality of the study they originate from; therefore an *ad hoc* quality assessment protocol was built, based upon recommendations on how to assess social science papers (Littell et al., 2008).

Studies selection

An initial inventory of relevant online databases was created. Scopus, ScienceDirect, and Google Scholar were identified as search engines from which to retrieve the studies to be included in the review. Google Scholar, ScienceDirect and

1 Scopus were selected as they use different approaches to index documents available on
 2 the internet. Since ScienceDirect and Scopus only index title, abstract and keywords
 3 documents containing search terms and keywords in the main text cannot be retrieved
 4 during the search process from those web engines. Instead, Google Scholar can select
 5 larger amount of documents compared to the other two search engines, as it indexes the
 6 documents' main text. Thus, by using them jointly the likelihood of retrieving articles
 7 related to the subject being investigated can be maximized (Ford, 2011).

8 The search process was restricted to research papers published in English in peer
 9 reviewed journals from 1999 to 2013. The choice of this time span was motivated by
 10 the fact that nutrition-modified and functional products started to be introduced in the
 11 market approximately at the end of the last century (Sirò et al., 2008) and by the time
 12 when the articles were collected (November 2013).

13 As illustrated in figure 1, the selection process continued with three steps in which
 14 inclusion/exclusion criteria reduced the number of studies gradually, by means of
 15 structured queries developed using Boolean operators and two sets of keywords. The
 16 first set of keywords included terms referring to the most frequently consumed
 17 nutrition-modified and functional dairy products according to Sirò (2008): "cheese",
 18 "yogurt", "butter", "milk" and "spread". The second set of keywords included the
 19 terms: "functional food", "vitamin", "omega-3", "fatty acid", "CLA" (Conjugated
 20 Linoleic Acid), "calcium", "antioxidant", "probiotic", "prebiotic", "fiber", "low fat",
 21 "light" and "low salt", which refer to the health-related attributes most frequently
 22 attached to dairy products (Playne et al., 2003; Sirò, 2008). Finally, the term
 23 "consumer" was added to the queries to identify only studies focusing on health-
 24 enhancing dairy products and consumers.

1 The search output initially included 3,617 articles: 895 identified via Scopus, 1,000
2 via Google Scholar, and 1,722 via ScienceDirect. In the first step, the language of the
3 study and the type of publications (e.g. research papers, reviews, and books) were used
4 as selection criteria. In the second step, titles and abstracts of the remaining 2065
5 papers were inspected, retaining only those focusing on issues related to consumer
6 behavior and nutrition-modified/functional foods. In the third step, the remaining 109
7 studies were further reduced by excluding 31 studies that were duplicates, and 36
8 which focused on the sensory profiles of these products without assessing aspects
9 related to consumer behavior. It is worth pointing out that more than half of the 42
10 articles identified to be reviewed appeared multiple times among the final set of 109
11 papers: as the same paper was retrieved by two or all of the three search engines at the
12 beginning of search process. The final list of the 42 articles identified to be included in
13 this review is reported in table 1.

14

15 *Quality Assessment*

16 The quality assessment procedure is one of the steps in the systematic literature
17 review process differentiating it from other types of reviews (Littell & College 2006;
18 Littell et al., 2008). This step requires the use of specific criteria to create a quality
19 score for each of the studies identified, and to produce a ranking of their quality. The
20 quality assessment was not easy to perform given the high heterogeneity of the
21 methodological approaches employed in this research domain, and because of the lack
22 of standardized quality assessment tools for studies belonging to the social science
23 field.

1 Therefore, similarly to Cox et al. (2015), an *ad hoc* quality assessment tool was
2 developed using the Instrument Critical Appraisal Checklist (2009) provided by the
3 Joanna Briggs Institute as a reference document.

4 This quality assessment protocol consists of six criteria, identified according to the
5 authors' expertise (Appendix table A.1.).

6 The first criterion considered whether the analysis performed was qualitative or
7 quantitative in nature. The adequacy of the sample size used and whether the sample
8 was representative of a specific population group were the second and third criteria
9 considered. The remaining three criteria were whether the study included a theoretical
10 framework, whether confounding factors and biases were accounted for in the
11 empirical analysis performed, and if the outcome variable of the study was measured
12 using a validated measure and/or one objectively quantifiable (e.g. probability to
13 observe an outcome, willingness to pay, Likert scale). For more details see table A.1 in
14 the Appendix.

15 The studies identified were rated as low, medium, or high quality, based upon a
16 combination of the scores assigned to each of the six assessment criteria; equal
17 weighting was given to each criterion. A study was considered as "high quality" if it
18 rated "high" on three or more criteria; "medium quality," if it received two "high" or
19 one "high" and two "medium"; the remaining studies were classified as "low quality."
20 For a complete list of the papers' scores in all the criteria and their overall quality
21 rating, see table A.2 in the Appendix.

22

23 **3. Results**

24 Table 1 presents a summary of the identified studies' features. The majority of the
25 studies identified (23 out of 42) were ranked as "high" quality, whereas, about three

quarters (32 out of 42), were ranked as either “high” or “medium” quality. The majority of the studies, circa 80%, were published between 2004 and 2013. Northern Europe, North America and Uruguay were the geographical areas most investigated. In terms of research design, 26 are single cross-sectional studies and show an average sample size of 504 observations, with a minimum number of observations of 50 and a maximum of 2,269; 8 studies are multiple cross-sectional studies, with sample sizes ranging from 96 to 5,967 observations, for an average of 1,602; two are longitudinal studies, one is a cohort study, and the remaining studies are based on exploratory research design (focus group interviews). The age of the consumers interviewed ranges from 14 to 90 years of age, with one study only focusing on consumers below the age of 30, and another on consumers above 65 years of age.

Generally speaking, the studies identified investigate aspects of consumer behavior by comparing two or more food carriers delivering different health-related properties. The most frequently investigated dairy food carrier, that is, the vehicle where bioactive ingredients can be incorporated or modified (*e.g.* beverages, bread, cereal, margarine, eggs), was yogurt (30 articles), followed by milk (11), cheese (10) and milk desserts (4). With regard to the health-related attributes, probiotic, ‘low fat content’, and omega-3 were the most studied (11 articles), followed by antioxidants (5), fiber (4), calcium (4), vitamins (2) and iron (1).

In terms of the data analysis techniques used, most of the studies adopted multivariate analysis techniques, such as analysis of variance or regression analysis. Data reduction techniques, like cluster analysis and principal component analysis, were employed in 9 out of 42 studies as intermediate techniques to identify consumers’ market segments on which to perform further analysis. For more details on the features of the studies included in this review, see table A.2 in the Appendix.

1

2 **3.1. Consumer related characteristics**3 *Gender*

4 The studies reviewed show the existence of a gender dimension in the acceptance
5 and preference for nutrition-modified and functional dairy products, with most studies
6 highlighting that women have higher levels of acceptance than men. Most of the
7 findings related to gender come from medium and high quality studies. For example,
8 Johansen et al. (2011) found more positive attitudes for low fat dairy products such as
9 yogurt and cheese among Norwegian, Danish and Californian female consumers,
10 compared to men. High female acceptance was mainly due to the fact that low-fat
11 products supported weight-control needs of many women which are, on average, also
12 more health consciousness than men (Wardle et al., 2014). Ares & Gambaro (2007) and
13 Ares et al. (2009) pointed out that female consumers attached the highest values of
14 willingness to try yogurts with added fiber or calcium. These dairy products were
15 highly accepted compared to other functional concepts. Furthermore, female consumers
16 showed positive attitudes for a functional dessert using milk as a base product (Ares et
17 al., 2009), and a higher acceptance was especially recorded among individuals with a
18 high level of personal involvement with the product (Ares et al., 2010a). A similar
19 result was obtained by Hailu et al. (2009), who investigated a sample of Canadian
20 consumers: these authors found that female consumers strongly prefer yogurt as a
21 carrier to deliver probiotics rather than using pills or ice cream as a vehicle. Females'
22 preferences for functional dairy products, especially for probiotic yogurt, also emerge
23 from one high quality study performed by Annunziata and Vecchio (2013) on a
24 representative sample of Italian consumers.

1 Other findings from high quality studies using self-reported and actual
2 consumption data confirmed the presence of a gender dimension. Landström et al.
3 (2007) pointed out that female Swedish consumers part of a focus group study,
4 declared that they consume/purchase more functional products than males, with a
5 significantly larger share of probiotic milk products. De Jong (2003) instead, using a
6 multivariate type of analysis and a large dataset of actual consumption data from the
7 Dutch population, found weak evidence that being female is positively associated with
8 the consumption of yogurt with added lactic acid bacteria, while the same was not
9 found for males.

10 However, few medium (Peng et al., 2006; Ares et al., 2010b) and high quality
11 (Siegrist et al., 2008; Cox et al., 2011) studies, found no gender difference in the
12 acceptance of yogurts added with Conjugated Linoleic Acid (CLA) or omega-3 (Peng
13 et al., 2006; Cox et al., 2011), antioxidants (Ares et al., 2010b) and other unknown
14 ingredients conferring risk reduction or general function features to yogurt (Siegrist et
15 al., 2008). These results may be due to, respectively, a general lack of consumers'
16 interest (regardless of gender), for yogurts added with CLA or omega-3 (as discussed in
17 the next section); the lack of consumers' familiarity with the term "antioxidants"; and
18 the suspicion for health claims not related to specific functional compounds. Generally
19 speaking, product familiarity, trust, and suspiciousness, are elements strongly linked to
20 the novelty aspect of health-enhancing food products and may affect their acceptance
21 (Bower et al., 2003; Urala & Lähteenmäki, 2007, Barrena & Sanchez, 2010). Also,
22 Urala & Lähteenmäki (2007) found no gender difference in the acceptance of
23 probiotic/stomach friendly yogurt and blood pressure lowering milk drinks, among
24 Finnish consumers, a result which may not be valid outside the Finnish
25 sample/population surveyed.

1 Thus, in the light of what is discussed above, the majority of the studies reviewed
2 converge in indicating females as the most likely consumers of nutrition-modified and
3 functional dairy products and particularly for products providing benefits linked to
4 intestinal well-being, weight loss and bone health. Functional dairy products promoting
5 bone health appear to be strongly preferred among females because of their higher risk
6 (compared to males) of developing osteoporosis (Ares & Gambaro, 2007; Hailu et al.,
7 2009).

8

9 *Age*

10 There is a general consensus among scholars that being older is positively
11 associated with a higher interest in dairy products with health-enhancing features,
12 especially for functional products with disease risk reduction properties. High quality
13 studies conducted by Urala & Lähteenmäki (2004; 2007) on a sample of Finnish
14 consumers found that older respondents were more willing to use functional foods with
15 claims to reduce the risk of a disease, such as blood pressure lowering milk drinks
16 (Urala & Lähteenmäki, 2004;2007). Older respondents seem to perceive these products
17 as more rewarding than younger consumers, since they can help counteract health
18 issues related to aging (Urala & Lähteenmäki, 2007). The perceived reward from
19 consuming functional foods, including functional dairy products, was indicated as
20 highly predictive of the willingness to use them (Urala & Lähteenmäki, 2004; 2007).
21 This result was also confirmed by another high quality study by Messina et al. (2008)
22 investigating a large cross-country sample of older consumers. These authors suggested
23 that their results may be due to older consumers having been exposed longer to
24 functional products compared to younger ones (Messina et al., 2008; Urala &
25 Lähteenmäki, 2004; 2007). Thus, older consumers have more knowledge and

1 familiarity with functional dairy products and their effects on health, and are more
2 likely to accept them.

3 Additional evidence, from high (Siegrist et al., 2008; Øvrum et al., 2012) and
4 medium quality studies (Peng et al, 2006; Ares & Gambaro, 2007; Ares et al., 2009),
5 corroborates the existence of a relationship between aging consumers and higher
6 acceptance of nutrition-modified and functional dairy products, confirmed by medium
7 and high quality studies using both self-declared and actual purchase data. Mullie et al.
8 (2012) recorded higher self-declared consumption of low fat dairy among older Belgian
9 consumers. Also, de Jong et al. (2003) found that being 65 or older is associated with
10 higher consumption of many functional products, including functional yogurt with
11 lactic acid bacteria (de Jong et al., 2003). Both Bonanno's (2012) study using Italian
12 actual purchase data, and Chase et al.'s (2009) study of Canadian consumers, found
13 that consumers increase their demand for functional yogurts and omega-3 added dairy
14 products as they grow older.

15 Younger consumers instead show overall higher acceptance for products enhancing
16 some physiological functions, such as those improving general well-being or those that
17 help prevent fatigue, compared to older respondents, as supported by a high (Urala &
18 Lähteenmäki, 2004) and a medium quality (Hailu et al., 2009) study. Only one study
19 found no difference in the acceptance for functional dairy products among individuals
20 belonging to different age groups (Landström et al., 2007).

21 In summary, the majority of studies identified in this systematic literature review
22 suggests that older consumers are more likely to accept willing to try, and to include
23 both nutrition-modified and functional dairy products in their diet. Older individuals
24 may constitute, along with women, the group of consumers most receptive to such
25 products, especially for functional products claiming to reduce the risk of diseases.

1

2 *Diet-health knowledge and lifestyles*

3 The studies reviewed found that variables related to consumer's level of knowledge
4 about the relationships between health and nutrition (Ares et al., 2008, Øvrum et al.,
5 2012) and in general to the consumer's nutritional knowledge, (Labrecque et al., 2006;
6 Whaba et al., 2006; Viana et al., 2008; Barenna & Sanchez, 2010) are good predictors
7 of consumer acceptance of some dairy products, such as probiotic yogurts, low-fat
8 products as well as products with added calcium, antioxidant and fiber. However, some
9 of the studies reviewed did not use validated measures to assess consumers'
10 knowledge, thus their results may need further validation by means of validated scales.
11 For example, Ares et al. (2008) exploring the role of nutritional knowledge on the
12 functional dairy acceptance, used an *ad hoc* modification of the Nutrition Knowledge
13 Questionnaire, developed by Parmenter and Wardle (1999) without assessing its
14 validity.

15 An additional hurdle in assessing the effect of consumers' diet-health related
16 knowledge on the acceptance of (and preference for) functional dairy products is that
17 many other factors can affect this relationship, for example family size. In families with
18 young children (below 12 years of age) parents feel more responsible for their health
19 (Barrios et al., 2008; Annunziata & Vecchio, 2013) and that may push them to acquire
20 more nutritional-, diet- and health-related knowledge. A similar increase can arise in
21 individuals who have had direct or indirect experience with illnesses, due to the
22 enhanced receptiveness to information regarding diet and health related issues (Van
23 Kleef, 2005a; Annunziata & Vecchio, 2013). Given the many factors affecting diet and
24 health-related knowledge, more analyses using multivariate analysis methods,
25 including mediation analysis, may be needed to isolate the role of nutritional/diet-

1 health knowledge on consumer acceptance of nutrition-modified and functional dairy
2 products.

3 Lastly, evidence from high quality studies points to a general consensus for
4 lifestyle variables (such as practicing sport and taking supplements) influencing the
5 acceptance of nutrition-modified and functional dairy products, as “wellness oriented”
6 consumers appear more willing to trade the taste of food for health benefits (Zandstra et
7 al., 2001; Landström et al., 2007). Although, at first glance, the group of health oriented
8 consumers may be seen as the ideal target for health-enhancing products, they represent
9 only a niche market. Food manufacturers’ efforts could otherwise be directed to
10 improve the taste of functional and nutrition-modified dairy products as a means to
11 enlarge their potential market and to reduce their price, which are often indicated as
12 barriers to health-enhancing products’ consumption (Frewer et al., 2003; Landstrom et
13 al., 2009).

14 15 *Psychological factors*

16 Many of the studies reviewed explored how psychological factors, recorded
17 through specific scales, can influence consumers’ preferences for health-enhancing
18 products. Among the studies surveyed, some investigated the role of consumers’
19 attitudes towards health and taste, on the acceptance of nutrition-modified and
20 functional dairy products, employing the health and taste scale originally developed by
21 Roininen et al. (1999).

22 Two high quality studies, conducted by Landström et al. (2007) and Zandstra, de
23 Graaf, & Van Staveren (2001) on samples of Swedish and Dutch consumers,
24 respectively, found that consumers who scored higher values of the ‘general health
25 interest’ and ‘light product interest’ scales, recorded higher consumption of low-fat
26 dairy products, conversely to those scoring higher for ‘craving for sweet’. Also,

1 according to another high quality study conducted by Labrecque et al. (2006), the
2 attitudes towards health and taste may also contribute to explain cross-cultural
3 preferences toward milk with omega-3 between Canadian, French and American
4 students, despite their low frequency of consumption.

5 Two successive high quality studies by Urala and Lähteenmäki (2004; 2007)
6 argued that functional foods differ from “conventional” healthy foods and thus the
7 general health scale was expected to be a weak predictor of consumers' functional food
8 choices. Therefore, they developed and used seven scales to predict the willingness to
9 consume selected functional foods. These authors found that the “*perceived reward of*
10 *improving your own health and performance*” best predicted consumers' willingness to
11 use milk added with calcium, blood pressure lowering milk drinks, and low-fat cheese.
12 However, although the perceived reward from consuming functional foods may predict
13 Finnish consumers' willingness to use functional dairy products, this result may not
14 apply to other cultures, as culture and food habits vary across countries. Therefore,
15 more cross-cultural studies are needed to confirm that perceived reward plays a role in
16 predicting consumers' use of functional dairy products.

17 Furthermore, as some functional foods are created by adding a bioactive ingredient
18 to a food carrier, adding an external ingredient can influence acceptance of the overall
19 product. Scholars have investigated consumers' acceptance of new functional
20 ingredients-dairy products combinations by using the food-neophobia scale, originally
21 proposed by Pliner & Hobden (1992). Empirical evidence from high quality studies
22 shows that food-neophobia is negatively correlated with the consumers' willingness to
23 buy probiotic yogurt, whereas it does not affect consumers' willingness to buy other
24 non-dairy functional products (Siegrist et al., 2008). Also, Urala & Lähteenmäki (2007)
25 report that consumers' neophobia was negatively correlated with the willingness to use

1 probiotic yogurts, but that it does not affect the use of other functional products, like
2 cholesterol-lowering spreads or milk with claims to lower blood pressure. On the one
3 hand, it is likely that food-neophobia may play a different role in relation to different
4 combinations of functional ingredients and carriers. On the other hand, results may be
5 confounded by the fact that, for consumers with high cholesterol blood level, there is a
6 “virtual prescription” for cholesterol lowering products, and that medical applications
7 have been found to suppress neophobia, or risk perception (Alevizos, Mihas & Mariolis
8 2007). Therefore, Urala & Lähteenmäki (2007) findings may be biased as they did not
9 account for the existence of cholesterol related problems in any of their respondents.

10 Since products with health-enhancing features are of recent market introduction,
11 the relationship between consumers’ attitudes towards food innovation and the
12 acceptance of such new products has been the object of investigation in some of the
13 studies included in this review. Almlí et al. (2011) conducted a cross-cultural study
14 where French and Norwegian consumers were asked to state their preferences toward
15 traditional cheese added with omega-3. In neither country the addition of omega-3 in
16 traditional cheeses showed a positive effect on the willingness to buy such product.
17 Even though the results from Almlí et al. (2011) suggest the existence of consumers’
18 aversion towards innovative health-food solutions, their results may be in part due to
19 consumers’ aversion to the match of omega-3 with dairy products, amply documented
20 in the next section.

21 A different approach was employed by Cox, Evans & Lease (2007), in their high
22 quality study. Using a Protection Motivation Theory framework (Rogers et al., 1975),
23 these authors found that perceived self-efficacy was the best predictor of the likelihood
24 of purchasing milk with omega-3 among a sample of Australian consumers. Compared
25 to other carriers containing omega-3, the authors found that omega-3-enriched milks

were the least likely to be purchased (Cox, Evans & Lease 2007). Also, a low quality study by Barrena and Sanchez (2010) used a means-end chain approach on a sample of sixty Spanish households to link their knowledge of *bifidus* added to yogurt and milk, to consequences and personal values related to this product, finding a major personal dimension in the purchase and consumption of *bifidus*-added dairy among households with children.

In summary, these studies find that psychological factors contribute to shape consumers' acceptance for nutrition-modified and functional dairy products. Consumers can become more interested in these products once they can perceive/believe in their health enhancing properties (for themselves and/or for people close to them). However, all the studies reviewed focus on North European consumers; therefore, research conducted in other Southern countries may be useful for food manufacturers as functional food markets are fast growing. For example, Italy saw the highest number of new healthy products launch among European Countries between 2005 and 2009 (Nutraingredients, 2009).

3.2 . Product related characteristics

Models assessing consumer acceptance and preferences by accounting for product characteristics populate the literature, along with those that explored consumers' perceived healthiness of many combinations of carriers and ingredients.

Intrinsic product characteristics

Intrinsic product characteristics can be defined as any informational stimuli of the physical product which cannot be changed without altering the essence of the product itself (Poulson et al., 1996). In the case of nutrition-modified and functional foods,

1 intrinsic product characteristics are given by the combination of the health-enhancing
2 ingredient with the type of carrier used.

3 Scholars' interest in consumers' perceived healthiness toward nutrition-modified
4 and functional foods was due to the fact that the latter is highly correlated with the
5 market success of the product and it was found being influenced by both intrinsic and
6 extrinsic product characteristics (discussed in the next session). Consumers' perceived
7 healthiness is usually measured on a seven-point Likert scale ranging from 1, 'not
8 healthy', to 7, 'extremely healthy' (Bech-Larsen & Grunert, 2003). The combinations
9 of carriers and ingredients receiving the highest perceived healthiness scores are more
10 likely to be accepted by consumers, and to succeed in the marketplace (Grunert, 2000;
11 Bech-Larsen & Grunert, 2003; Krutulyte et al., 2008, 2011; Johansen et al. 2011; Cox
12 et al., 2011).

13 Several of the studies identified in this review have investigated the perceived
14 healthiness of carriers, ingredients and their combinations. Studies with different
15 quality levels show that the perceived healthiness of a dairy product largely depends
16 upon the consumer's perceived healthiness of the carrier (Ares et al., 2008; Hailu et al.,
17 2009); others (van Kleef et al., 2005a; Hailu et al., 2009; Johansen et al., 2011) pointed
18 to yogurt being perceived as the healthiest carrier among those tested, perhaps because
19 yogurt is perceived as intrinsically healthy.

20 Furthermore, a number of mostly high quality studies among those reviewed, also
21 indicate that consumers show strong acceptance for selected ingredients such as
22 calcium and fiber, and a more positive perceived healthiness of health-enhancing foods
23 where the bioactive ingredient is "naturally added" or it is inherent to the carrier (Cox
24 et al., 2011; Krutulyte et al., 2008, 2011). For example, yogurt with added calcium is
25 perceived as healthier than yogurt with added fibers, antioxidants and iron (Ares &

1 Gambaro, 2007). Instead, yogurts added with omega-3 are perceived negatively, since
2 they are characterized by a combination perceived as less natural than, for example,
3 omega-3 and fish products (Krutulyte et al., 2011). Additionally, consumers struggle to
4 associate the fish taste of omega-3 with the sweetness of yogurt, and are skeptical of
5 the potential off-flavors produced by the addition of such ingredient to yogurt
6 (Krutulyte et al., 2011). Low consumer acceptance for dairy products added with
7 omega-3 was also confirmed by Chase et al. (2009) using Canadian purchase data
8 matched with household related information. They found that more than 90% of the
9 7,947 households surveyed never purchased omega-3 added products. However,
10 moderate acceptance of omega-3 modified dairy products was recorded among
11 individuals who perceived the risk of conditions associated with a metabolic syndrome
12 (O'Brien et al., 2012).

13 Limited evidence exists, from medium and high quality studies, in support of the
14 effectiveness of adding “external” ingredients to products considered unhealthy in
15 order to improve their acceptance. In some cases, carriers with an unhealthy image,
16 such as cheeses or spreads, known for their high cholesterol content, were perceived as
17 good carriers for bioactive ingredients such as polyunsaturated fat or omega-3,
18 mitigating the negative effect of cholesterol on health (Bech-Larsen & Grunert, 2003;
19 Peng et al., 2006). In these cases consumers may simply prefer health-enhancing dairy
20 products whose bioactive ingredients “enhance” the innate or intrinsic properties of the
21 product without altering its sensory characteristics, regardless on whether the ingredient
22 is a “natural” addition to the carrier or it is exogenous to it.

23 Given the findings presented above, there appears to be a widespread consensus
24 in the literature that a “natural” match between added ingredient and carrier increases
25 the overall acceptance of functional dairy products with health-enhancing features.

Extrinsic product characteristics

Extrinsic product characteristics are informational stimuli which are not physically part of the product, e.g. a product's label and its elements (Grunert et al., 1996). In the case of food products with health-enhancing features, extrinsic attributes are nutrition and health claims available on the labels, a product's brand, and its package. These characteristics work usually as tools to inform consumers about the product's properties, and to attract and influence shoppers' purchasing decisions. The existing literature provides conflicting results on how nutrition and health claims affect consumers' acceptance of nutrition-modified and functional dairy products (Bech-Larsen & Grunert, 2003; Ares et al., 2009; Ares et al., 2010b). A medium and a high quality study identified in this systematic review suggest that individuals prefer dairy food products with health and nutrition claims rather than identical ones without a claim, suggesting that the presence of a claim increases the healthiness perception of products and therefore their acceptance (Bech-Larsen & Grunert, 2003; Ares et al., 2009). A high quality study by Lähteenmäki et al. (2010) found no effect, or a slightly negative one, of the presence of health claims on consumer perceived healthiness by investigating a large sample of north European consumers.

Results of high quality studies indicate that the presence of nutrition and health claims may guide some groups of consumers in making healthier food choices (Marette et al., 2010; Øvrum et al., 2012), and that these consumers are also willing to pay a premium price for those food products. In particular, female consumers with diet-health knowledge (Øvrum et al., 2012) and consumers with chronic diseases (Marette et al., 2010) seem to be the groups who are both willing to pay higher prices for dairy products with health-enhancing features, and to take nutrition and health claims into

1 account in their food decisions process (Marette et al., 2010; Øvrum et al., 2012).
 2 However, some evidence from low/medium quality studies indicates that the presence
 3 of nutrition claim generates negative effects on consumers' perceived pleasantness
 4 from the consumption of reduced fat dairy products (Kähkönen & Tuorila, 1999,
 5 Johansen et al., 2011), effectiveness which is mitigated in health-conscious consumers
 6 committed to healthy eating habits, and less demanding about food taste (Johansen et
 7 al., 2011).

8 Health claims guarantee different levels of health efficacy and convey different
 9 health benefits (e.g. cholesterol reducing effects, support of the immune system, and
 10 support of bone health) (Bimbo et al., 2016). A high (van Kleef et al., 2005a) and a
 11 medium quality (Williams et al., 2008) study suggest that, among the many claims
 12 available in the marketplace, consumers prefer overall health claims to nutrition claims,
 13 and risk disease reduction claims to general function ones. Interest in risk reduction
 14 claims is found in highly educated consumers, often females, who have been directly or
 15 indirectly exposed to diseases, in consumers with a high level of diet-health related
 16 knowledge (Williams et al., 2008; Ares et al., 2010b), and in those using nutritional
 17 supplements (Hailu et al., 2009). Similar findings were reported by Annunziata &
 18 Vecchio (2013) in their high quality study. These authors identified a consumer cluster
 19 composed mainly of highly educated females with children under 12 years of age, and
 20 of consumers adopting healthy diets, who preferred dairy products with risk reduction
 21 claims rather than other claims; the other cluster of respondents in their sample
 22 preferred generic claims related to the enhancement of general well-being (Annunziata
 23 & Vecchio, 2013).

24 The results presented above do not depict clear patterns in consumers' acceptance
 25 for nutrition and health claims available in the market place. Results seem to vary

1 according to how relevant a specific nutritional/health claim is, for the group of
2 consumers examined. However, many high quality studies point to woman with diet-
3 health knowledge, individuals with chronic diseases, and highly educated consumers,
4 as those consumers groups which are more likely to take into account nutrition and
5 health claims in their food choices, as well as to pay higher price for health-enhanced
6 dairy versions. Additionally, consumers interested in dairy products with health claims
7 may have a higher ability to understand them and to process the information conveyed
8 by the health claims (Nocella & Kennedy, 2012). Furthermore, claims are often
9 formulated in complicated terms: shorter, easier to understand claims, may increase the
10 acceptance of functional dairy products and facilitate the recovery of the high
11 investment costs undertaken to develop and to market them (Siegrist et al., 2008).

12 With regard to brand, Deliza & MacFie (1996) identify it as one of the most
13 important extrinsic attributes influencing consumers' purchasing decisions for food
14 products. Brands can signal quality and the manufacturer's guarantee of the truthfulness
15 of what is declared on the package (Deliza & MacFie, 1996). Similar findings emerge
16 from studies investigating consumer acceptance and preference for nutrition-modified
17 and functional dairy products (Ares et al., 2010a; Ares & Deliza, 2010; Barrena &
18 Sanchez, 2010; Annunziata & Vecchio, 2013).

19 The high quality study by Messina et al. (2008) showed that the influence of brand
20 on older consumers' choices differs across countries, as older consumers from South
21 America and Southern Europe are influenced more than those from other countries.
22 Among medium quality studies, Ares et al. (2010a) found that brand affects willingness
23 to purchase functional milk dessert, while Ares et al. (2010b) found that brand was the
24 second attribute for magnitude, after carrier, to affect consumer choice of functional

1 yogurts, and that the impact is as high as carrier, in affecting consumer's preferences
2 among middle aged females.

3 Similar results emerge from the high quality study performed by Annunziata &
4 Vecchio (2013), where brand affects the choice of probiotic yogurts among a segment
5 of young Italians with an average level of education, lower probability to engage in
6 healthy eating habits, and low consumption frequency of probiotic dairy yogurt
7 (Annunziata & Vecchio, 2013); the same study also finds that brand's effect in shaping
8 consumers' choices increases with consumers' familiarity with the brand, while brands
9 do not affect food decisions in consumers with interest in health (Annunziata &
10 Vecchio, 2013), confirming findings of other studies (Barrios et al., 2007; Ares et al.,
11 2010b).

12 Results of medium and high-quality studies supporting the notion that the brand
13 positively affects consumers' attitudes and preference toward health-enhancing dairy
14 products, were also found in two of the low-quality studies reviewed (Barrena &
15 Sanchez, 2010; Ares & Deliza, 2010). Barrena & Sanchez (2010) found that brand
16 familiarity is one of the product's characteristics evaluated by households during their
17 decision process to purchase probiotic milk (Barrena & Sanchez, 2010), while Ares &
18 Deliza (2010) pointed out that brand was one of the most frequently mentioned item,
19 after flavor, color and shape of the package among nutrition-modified milk desserts'
20 packages features influencing purchases (Ares & Deliza, 2010).

21 The findings presented above show a general consensus among the literature
22 reviewed that brand increases the acceptance and motivates consumers' choice of
23 nutrition-modified and functional dairy products over conventional ones. Such
24 influence is particularly strong among consumers who are less likely to engage in a
25 healthy lifestyle, while they have little to no effect on the choices of consumers with

1 high interest in health. However, these results may be confounded by country-specific
 2 differences in education, in the proportion of individuals engaging in healthy lifestyles,
 3 and in the development stage of the health-enhancing foods' market. Last, packaging is
 4 another extrinsic product characteristic that attracts consumers' attention and can
 5 influence their purchasing decisions of health-enhancing dairy products. Among the
 6 studies identified, we found little emphasis on this factor. Ares & Deliza (2010)
 7 explored the effect of packaging's attributes on consumer willingness to purchase
 8 nutrition-modified chocolate milk desserts. They found that the color and shape of
 9 packaging influence consumers' purchasing decisions and that brown packaging
 10 increases consumers' purchasing intentions for such dessert. Packaging shape, instead,
 11 shows mixed effects on consumers' intention to purchase a low-fat dessert, depending
 12 upon the expectations regarding the product's texture that the package shape generates
 13 in the consumers' minds (Ares & Deliza, 2010). In summary, Ares & Deliza's (2010)
 14 study proves that package's features affect consumers' acceptance and purchasing
 15 decisions, however more research is needed on this topic to corroborate the results of
 16 this study.

17 **4. Discussion, limitations and future research**

18
 19
 20 A systematic literature review technique was used to collect and consolidate the
 21 existing knowledge on consumers' acceptance and preferences toward nutrition-
 22 modified and functional dairy products. The quality of the studies identified was
 23 assessed by means of an *ad hoc* tool, and the studies' findings organized to give an
 24 overview of major factors influencing consumer behavior toward these products.

25 Overall, the findings of our systematic review support the existence of clear
 26 patterns characterizing consumers' acceptance and preferences for nutrition-modified

1 and functional dairy products, differently than previous systematic reviews including
2 studies covering different product categories (Ozen et al., 2012; Ozen et al., 2014) and
3 in line with other reviews on consumer acceptance and preferences for health-
4 enhancing food products (e.g. Frewer's et al. 2003; Siro's et al. 2008; and
5 Lähteenmäki, 2013).

6 Our results confirm that gender and age play an important role in explaining
7 different patterns of acceptance in relation to identified combinations of carriers and
8 ingredients. Female consumers are more willing to use, and to include in their diet
9 yogurt enriched with calcium, fiber and probiotics as well as consuming low-fat dairy
10 products. Willingness to use/purchase functional and nutrition-modified dairy products
11 increases with age, as older consumers perceive higher rewards from consuming such
12 food versions, and show more interest in health. Therefore, female and older consumers
13 characterize the groups of consumers likely to be most receptive to nutrition-modified
14 and functional dairy products; as elderly people are the main users of resources within
15 healthcare systems, and through promoting the consumption of dairy products with
16 health enhanced features may improve their health and may have a beneficial impact on
17 reducing national health care expenditure.

18 Our findings also support that diet-health and nutritional knowledge contribute to
19 explain consumers' acceptance of nutrition-modified and functional dairy products;
20 however, more research is needed in this area as most of the studies identified have
21 used non-validated scales to assess this relationship. Consumer psychological traits also
22 contribute to shape consumers' acceptance and preferences for nutrition-modified and
23 functional dairy products. Among intrinsic product attributes, carriers appear as the
24 most effective in influencing consumers' perceived healthiness; their effect is positive
25 when a "natural" match between the carrier and the bioactive ingredient exists, and

1 negative for “unnatural” matches, such as omega-3 added to yogurt. More research is
2 needed on the role of different nutrition and health claims, as the existing literature
3 provides conflicting results which may largely depend on the relevance of the nutrition
4 or the health claim surveyed for the sample selected.

5 A novel result of this systematic review is that extrinsic product's characteristics
6 such as a product's brand, and its package's features affect strongly consumers' choices
7 for nutrition-modified and functional dairy products. Some of the studies included in
8 this review pointed at brand as being the second most important product attribute, after
9 the carrier, affecting consumers' evaluation of yogurt added with fiber and antioxidant.
10 Also, brand recognition drives consumers' choice of yogurt with general functional
11 claims among middle age Italian females with a sedentary lifestyle, and among Spanish
12 households with children. Instead, a product's brand does not play a role when
13 consumers chose dairy products with risk-reduction health claims. Further, we
14 identified one study exploring consumers' preferences for package's characteristics of
15 nutrition-modified food products, which found that the package's features, such as its
16 color, shape the consumer's preferences for low fat milk dessert shape consumers'
17 expectations about the food product.

18 These novel findings may provide beneficial for manufacturers of nutrition-
19 modified and functional dairy products, as they suggest the need to invest in building
20 brand reputation to ensure market success. However, as consumers' interest in disease
21 risk reduction claims does not seem affected by brand familiarity, firms investing in
22 risk reduction claims may find it more profitable to focus their efforts in claim-
23 developing activities, rather than in brand advertising. Furthermore, the success of
24 nutrition-modified and functional products may be facilitated by marketing activities

1 focusing on creating food packages which attract the consumers' attention and interest
2 for such products.

3 Our study has three main limitations. First, our findings apply only to the
4 acceptance and preferences for dairy products, and, as such, our analysis is limited in
5 scope. Future research should focus on assessing consumer's behavior for others food
6 categories, as well as the interrelationships between cross categories choices, which
7 does not seem to have been explored so far.

8 Second, even though we are aware that taste stimuli play a pivotal role in food
9 choices, and that a functionality/nutrition-modified feature provides added value to
10 consumers as long as it doesn't modify the sensory properties of a food product original
11 food (Verbeke, 2005; Bech-Larsen and Scholderer, 2007), we excluded this bulk of
12 literature from this study as it is too vast and it deserves its own analysis. Thus, future
13 research should account for the role played by taste stimuli on consumer's choices of
14 functional/nutrition-modified food products.

15 Third, even though we aimed to provide a comprehensive picture of the many
16 drivers affecting consumer acceptance and preferences for nutrition-modified and
17 functional dairy products, the majority of the findings analyzed came from studies
18 performed in Northern European countries, with few from Southern European and
19 American countries. Therefore, in order to understand cultural, psychological and other
20 aspects of purchasing behavior in other national contexts, more research needs to be
21 conducted in Mediterranean, American and Asian countries. Expanding the pool of
22 countries subject of analysis can allow food companies to reach international audiences
23 more effectively.

24 The findings of this review also open to the possibility of new avenues of research.
25 In the first place, some of our findings indicate that brand affects consumer's food

1 choices when it is associated with nutrition and health claim. Future research should
 2 explore the possibility that consumers' acceptance and preferences for a product's
 3 feature may vary conditionally on the support provided by different brands. As it is
 4 well-known that a brand name may act as an additional guarantee of a label's
 5 truthfulness, more research on the interaction of different types of brand names and
 6 consumers' attitude towards specific features may provide beneficial for food
 7 manufacturers.

8 Last, it should be mentioned that none of the studies reviewed was conducted using
 9 methods aimed to improve the realism of choice experiments, such as virtual reality-
 10 based methods. As those methods are meant to increase their external validity (Van
 11 Herpen et al., 2016) they lend for their results to be more comparable across studies,
 12 which was one of the hurdles we faced in this systematic review and which is, in
 13 general, due to the fact that survey-based methods show high heterogeneity in study
 14 design (Van Kleef et al., 2005b). Future research should consider exploiting these new
 15 tools to corroborate the findings of survey-based research and, when a numerous
 16 enough body of research is available, to validate the findings of this review.

17

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1

2 Figure 1. Selection papers process.

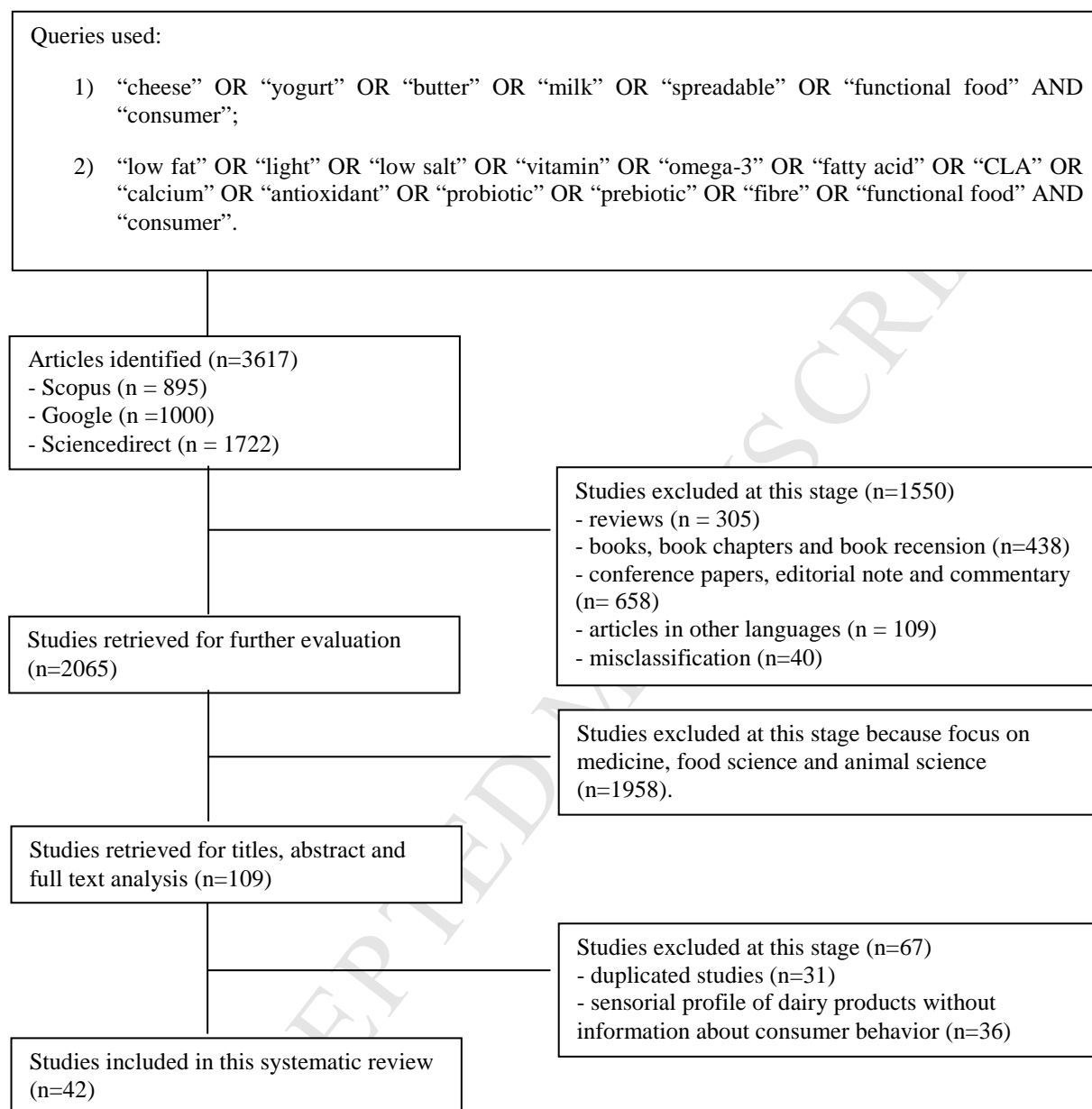


Table 1. Summary of the studies, quality ranking and research area covered.

Study	Quality	Area covered				
		Gender	Age	Diet-health knowledge and lifestyle	Perceived healthiness and product attributes	Psychological factors
Almli et al. (2011)	Medium					X
Annunziata & Vecchio (2013)	High	X		X	X	
Ares & Deliza (2010)	Low				X	
Ares & Gambaro (2007)	Medium	X			X	
Ares et al.(2008)	Low			X	X	
Ares et al.(2009)	Medium	X	X		X	
Ares et al.(2010a)	Medium	X			X	
Ares et al.(2010b)	Medium	X			X	
Barrena & Sanchez (2010)	Low			X	X	X
Barrios et al. (2007)	Low			X		
Bech-Larsen & Grunert (2002)	High				X	
Bonanno (2012)	High		X			
Chase et al.(2009)	High		X	X	X	
Cox et al. (2007)	High					X
Cox et al.(2011)	High	X				
de Jong et al. (2003)	High		X	X		
Grunter et al. (2000)	Medium					
Hailu et al. (2009)	Medium	X	X	X	X	
Johansen et al. (2011)	Medium	X			X	
Kahkonen & Tuorila (1999)	Low				X	
Krutulyte et al. (2008)	High				X	
Krutulyte et al. (2011)	High				X	
Labrecque et al. (2006)	High			X		X
Lähteenmäki et al.(2010)	High				X	
Landström et al. (2007)	High	X	X	X		X
Landström et al. (2009)	Low			X		
Marette et al. (2010)	High				X	
Maynard (2005)	Low				X	
Messina et al.(2008)	High		X		X	
Mireaux et al. (2007)	Low					
Mullie et al. (2013)	High		X			
O'Brien et al. (2012)	High				X	
Øvrum et al. (2012)	High		X	X	X	
Peng et al. (2006)	Medium	X	X		X	
Siegrist et al. (2008)	High	X	X			X
Urala & Lähteenmäki (2004)	High		X			X
Urala & Lähteenmäki (2007)	High	X	X			X
van Kleef et al. (2005a)	High			X	X	
Viana et al., (2008)	Low			X		
Wahba et al. (2006)	Medium			X		
Williams et al. (2008)	Low				X	
Zandstra et al. (2001)	Medium			X		X

Table A.1. – Study attributes and criteria of the quality assessment tool used in this review

Studies attribute	Criteria assessed	Quality rating		
		Low	Medium	High
Methodology	What it is the methodology researchers used in this study?	Qualitative	n/a	Quantitative
Sample size	Is the sample size adequate?	Less than 49	Between 50 and 500	Over 500
	Is the sample representative for the population or of the group of interest?	No	n/a	Yes
Is a theoretical model employed?	Theory driven results?	No	n/a	Yes
Confounders and bias	Are potential confounders minimized?	Confounders or sample selection not adequately described.	Confounders minimized or explicitly stated.	Confounders controlled for in study design or analysis.
Outcome measurement ?	Is the outcome measure validated and/or objectively quantifiable?	No, it is not validated and/or it is not an objectively quantifiable measure.	n/a	Yes, it is a validated and/or objectively quantifiable measure.
Overall rating		No or one high rating (excluded the case of one high and two medium)	Two high ratings– or one high rating and two medium	Three or more high ratings

¹ The Joanna Brigg's Institute Instrument Critical Appraisal Checklist was used to build the quality assessment tool employed in this paper.

Table A.2. – Quality assessment table¹ summarizing studies on consumer acceptance and preference for dairy functional foods.

Author, date	What it is the methodology researchers used in this study?	Sample size adequate?	Is sample representative?	Theory driven results?	Are potential confounders minimized?	Is the outcome measure validated and/or objectively quantifiable?	Overall rating
Almli et al., 2011	High Quantitative (ANOVA)	Medium N=239	Low No	Low No	Medium Explicitly stated (the samples are biased towards a good perceived economic situation for the household)	Low No (willingness to buy scale)	Medium
Annunziata and Vecchio, 2013	High	High	High	Low	High	High	High
	Quantitative (ANOVA and cluster analysis)	N=600	Yes (representative of Italian population)	No	Yes, clear inclusion criteria	Yes (perceived healthiness scale)	
Ares and Delizia, 2010	Low	Medium	Low	Low	Low	Low	Low
	Qualitative (free listing and word association)	N=100	No	No	No (no random sample)	No	
Ares and Gambaro, 2007	High	Medium	Low	Low	Low	High	Medium
	Quantitative (ANOVA and cluster analysis)	N=200	No	No	No (missing considering other socio demographic variables)	Yes (perceived healthiness scale)	
Ares et al., 2010a	High	Medium	Low	Low	Medium	Low	Medium
	Quantitative (ANOVA and cluster analysis)	N=107	No	No	Explicitly stated (sample overrepresentative of female consumers)	No	
Ares et al., 2010b	High	Medium	Low	Low	Medium	High	Medium
	Quantitative (ANOVA and cluster analysis)	N=103	No	No	Explicitly stated (sample composed of typical middle class consumers)	Yes (part-worth utility)	

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Ares et al., 2008	High Quantitative (ANOVA and cluster analysis)	Medium N=104	Low No	Low No	Low No (modified and not validated Food nutritional knowledge questionnaire)	Low No	Low
Ares et al., 2009	High Quantitative (ANOVA and cluster analysis)	Medium N=82	Low No	Low No	Medium Explicitly stated (low share of functional food consumers compared to non-consumers)	High Yes (perceived healthiness scale)	Medium
Barrena and Sanchez, 2010	Low Qualitative (means-end chain approach)	Medium N=60	Low No	High Yes (empirical framework built upon previous literature)	Low No (convenience sample)	Low No	Low
Barrios et al., 2008	Low Qualitative (focus group)	Medium N=59	Low No	Low No	High Yes (clear inclusion criteria)	Low No	Low
Bech-Larsen and Grunert, 2002	High Quantitative (ANOVA)	High N=1533	Low No	Low No	Low No (sample not adequately described)	High Yes (perceived healthiness scale)	High
Bonanno, 2010	High Quantitative (random coefficients logit model)	High N=4488	Low No	High Yes (microeconomic theory)	High Yes (consumption data of real products)	High Yes (consumer's utility)	High
Chase et al., 2009	High Quantitative (ordered probit model)	High N=7947	Low No	High Yes (microeconomic theory)	High Yes (consumption data of real products)	High Yes (consumer's utility)	High
Cox et al., 2007	High Quantitative (multiple regression model)	Medium N=220	High Yes (in age, gender)	High Yes (Protection Motivation Theory)	High Yes (clear inclusion criteria)	High Yes (likelihood to purchase)	High

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Cox et al., 2011	High Quantitative (ANOVA)	Medium Study 1 (n = 202), Study 2 (n = 211)	Low No	High Yes (Protection Motivation Theory)	Medium Explicitly Stated (sample generally biased in favour of acceptance of the GM technology)	High Yes (consumer's utility)	High
de Jong et al., 2003	High Quantitative (logistic regression)	High N=1183	Low No	Low No	Medium Explicitly Stated (sample with larger share of female than male consumers)	High Yes (probability of outcome)	High
Grunert et al., 2000	High Quantitative (conjoint Analysis)	Medium N=426	Low No	Low No	Low No (sample not adequately described)	High Yes (perceived healthiness scale)	Medium
Hailu et al., 2009	High Quantitative (conjoint analysis and cluster analysis)	Medium N=267	Low No	Low No	Medium Explicitly stated (sample underrepresentation of certain groups (e.g., ethnicity) and overrepresentation of others (e.g., high educated and young consumers)	High Yes (consumer's utility)	Medium
Johansen et al., 2011	High Quantitative (dual sorting test)	Medium N=370	Low No	Low No	Low Explicitly Stated (University student sample)	High Yes (consumer's utility)	Medium
Kahkonen and Tuorila, 1999	High Quantitative (analysis of variance)	Medium N=253	Low No	Low No	Low No (Sample not adequately described and some socio economic variable missed in the analysis)	Low No (pleasantness and buying probability)	Low
Krutulyte et al., 2008	High Quantitative (quantitative network representation)	Low N=21	Low No	High Yes (Health Action Process Approach)	Low Unclear (results probably affected by the larger share of young consumers)	High Yes (behavioural intentions)	High

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Krutulyte et al., 2011	High Quantitative (logistic regression)	High N=959	Low No	High Yes (Ad hoc conceptual framework built on the literature)	Low Unclear (sample overrepresentative of female consumers 75%)	High Yes (probability)	High
Labreque et al., 2006	High Quantitative (linear regression)	High N=545	Low No	Low No	Medium Sampling criteria sufficiently described	High Yes (outcome from validated scales)	High
Lähteenmäki et al., 2010	High Quantitative (linear regression and Scheffe test)	High N=4612	Low No	Low No	Medium Sampling criteria sufficiently described	High Yes (perceived healthiness scale)	High
Landström et al., 2007	High Quantitative (t-test, principal component analysis and logistic regression)	High N=972	Low No	Low No	Medium Explicitly Stated (sample biased towards consumers favouring the concept of functional food)	High Yes (outcome from validated scale)	High
Landström et al., 2009	Low Qualitative (focus group)	Low N=46	Low No	Low No	Medium Sampling criteria sufficiently described	Low No	Low
Marette et al., 2010	High Quantitative (censored pooled regression)	Medium N=97	High Yes	High Yes, experimental theory design.	High Clear inclusion criteria and randomization experimental design.	High Yes (willingness to pay)	High
Maynard L.J., 2005	Low No (descriptive statistics)	Medium N=111	Low No	Low No	Low No (sample not adequately described)	High Yes (willingness to pay)	Low

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Messina et al. 2008	High	High	Low	Low	High	Low	High
	Quantitative (repertory grid method)	N=768	No	No	Yes (clear inclusion criteria)	No	
Mireaux et al., 2007	High	Medium	Low	Low	Low	Low	Low
	Quantitative (repertory grid method)	N=72	No	No	No (sample not adequately described)	No	
Mullie et al., 2012	High	High	High	Low	Medium	High	High
	Quantitative (regression model)	N=1852	Yes	No	Sampling criteria sufficiently described	Yes (consumption data)	
Ovrum et al., 2012	High	Medium	Low	High	Low	High	High
	Quantitative (random ordered mixed logit)	N=408	No	Yes, experimental theory design	No (internet survey with no information on how authors selected the participants)	Yes (willingness to pay)	
O'Brien et al., 2012	High	High	High	High	Low	Low	High
	Quantitative (t-test and principal component analysis)	N=5067	Yes	Yes (Health Belief Model)	Unclear random selection	No	
Peng et al., 2006	High	High	Low	Low	Low	Low	Medium
	Quantitative (factor analysis and ordered logit model)	N=803	No	No	Unclear random selection	No (unbalance likely of buying scale)	
Siegrist et al., 2008	High	Medium	Low	High	High	Low	High
	Quantitative (ANOVA, PCA, regression)	N=249	No	Yes (Food Neophobia scale)	Clear inclusion criteria	No (willingness to buy, unclear scale and benefits provided by carriers)	

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Urala and Lahateenmaki, 2004	High	High	Low	High	High	High	High
	Quantitative (Factor analysis and ANOVA)	N=1158	No	Yes (general health interest and natural product interest)	Yes (confounder clearly minimized)	Yes (willingness to use, 7-points scale)	
Urala and Lahateenmaki, 2007	High	High	Low	High	High	High	High
	Quantitative (Factor analysis and MANOVA)	N= 2269	No	Yes (general health interest and natural product interest)	Yes (confounder clearly minimized)	Yes (willingness to buy, 7-points scale)	
van Kleef et al., 2005	High	Medium	Low	High	High	High	High
	Quantitative (Factor Analysis and ANOVA)	N=124	No	Yes (experimental design and testing specific hypotheses)	Yes (selective sample)	Yes (intention to buy, 7-points scale)	
Viana et al., 2008	Low	Medium	Low	Low	Low	High	Low
	Qualitative (descriptive statistical analysis)	N=420	No	No	No (knowledge of probiotic with open-ended questions)	Yes (probability)	
Wahba et al., 2006	Low	High	Low	Low	Low	High	Medium
	Qualitative (descriptive statistical analysis)	N=820	No	No	No (general type ok knowledge analysed)	Yes (probability)	
Williams et al., 2008	High	Medium	Low	Low	Low	Low	Low
	Quantitative (ANOVA and Regression analysis)	N=149	No	No	No (not a random sample)	No (information on scale measures is missing)	
Zandstra et al., 2001	High	Medium	Low	High	Low	High	High
	Quantitative (ANOVA)	N=132	No	Yes (validated health and taste attitudes scales)	No (not a random sample)	Yes (total dietary behaviour)	

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